
GSA
Public Buildings Service

INDOOR FIRING RANGE
DESIGN, OPERATIONS & MAINTENANCE CRITERIA

April 2012

FORWARD

The General Services Administration (GSA) operates a number of indoor firing ranges in support of multiple federal agencies. This criteria document was developed as a benchmark against which firing range design, operation, and maintenance performance could be measured. The use of the criteria in evaluating firing range performance is part of an overall goal to better conform to GSA directives for minimizing environmental impacts and implementation of sustainable management practices.

The criteria were derived from numerous other guidance documents related to indoor firing range performance as well as the specific experience of team members related to firing range design and operation. Each criterion was modified as appropriate to address the specific needs and experience of the GSA in managing their ranges.

NOTE: The White House Office of Management and Budget (OMB) has agreed with GSA that no new firing ranges should be constructed in Federal buildings, including courthouses and border stations. Agencies seeking an exception from this policy must submit a justification to OMB for consideration.

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TABLE OF CONTENTS

| | | |
|------------|---|-----------|
| | List of Acronyms | v |
| 1.0 | INTRODUCTION..... | 1 |
| 1.1 | Firing Range Basics | 2 |
| 1.2 | Safety and Compliance | 2 |
| 2.0 | DESIGN CRITERIA..... | 3 |
| 2.1 | General Range Layout | 3 |
| 2.1.1 | Dimensions..... | 3 |
| 2.1.2 | Firing Line..... | 3 |
| 2.1.3 | Shooting Lanes..... | 4 |
| 2.1.4 | Openings and Egress | 4 |
| 2.1.5 | Range Safety Officer Control Room | 4 |
| 2.1.6 | Target Retrieval System..... | 4 |
| 2.1.7 | Support Facilities | 4 |
| 2.2 | Ballistic Design..... | 5 |
| 2.2.1 | Floors | 5 |
| 2.2.2 | Walls | 5 |
| 2.2.3 | Ceilings..... | 6 |
| 2.2.4 | Bullet traps..... | 7 |
| 2.3 | Ventilation | 7 |
| 2.3.1 | Air Flow through Range | 7 |
| 2.3.2 | Negative Pressure | 8 |
| 2.3.3 | Supply Plenums..... | 8 |
| 2.3.4 | Ducts | 8 |
| 2.3.5 | Supply/Exhaust..... | 8 |
| 2.3.6 | Air Controls..... | 8 |
| 2.3.7 | Filters | 8 |
| 2.4 | Noise..... | 9 |
| 2.4.1 | Reduction | 9 |
| 2.4.2 | Ambient Noise | 9 |
| 2.4.3 | Acoustical Treatment | 9 |
| 2.5 | Lighting | 10 |
| 3.0 | OPERATIONS AND MAINTENANCE CRITERIA..... | 10 |
| 3.1 | Facilities Cleaning | 10 |
| 3.2 | Signage | 11 |
| 3.3 | Communication..... | 11 |
| 3.4 | Alarms | 12 |
| 3.5 | Inspection and Testing..... | 12 |
| 3.6 | Exposure | 12 |
| 3.6.1 | Hearing Conservation | 12 |
| 3.6.2 | Airborne Lead within Range | 13 |
| 3.6.3 | Lead Dust | 14 |
| 3.6.4 | Carbon Monoxide | 15 |
| 3.6.5 | Hygiene | 15 |

| | | |
|------------|--------------------------------|-----------|
| 3.7 | Waste Management..... | 15 |
| 3.7.1 | Recycling..... | 15 |
| 3.7.2 | Hazardous Waste | 15 |
| 3.8 | Recordkeeping | 15 |
| 3.8.1 | Activity Records..... | 15 |
| 3.8.2 | Maintenance Plan..... | 16 |
| 3.9 | Limitations..... | 16 |
| 4.0 | LIST OF REFERENCES..... | 18 |

Tables

| | |
|---------|--------------------------------------|
| Table 1 | Small Arms Peak Noise Levels |
| Table 2 | Calculating Lead Exposure |
| Table 3 | Indoor Firing Range Criteria Summary |

Figures

| | |
|----------|-----------------------------|
| Figure 1 | Typical Range Cross-Section |
| Figure 2 | Typical Range Plan View |

Appendices

| | |
|------------|-------------------------------------|
| Appendix A | Summary of Source Guidance Material |
| Appendix B | Ballistic Safety References |
| Appendix C | Range Acoustics Guide |

List of Acronyms

| | |
|---------------------------|---|
| ACGIH | American Conference of Governmental Industrial Hygienists |
| ANSI | American National Standards Institute |
| ASTM | American Society of Testing Materials |
| BHN | Brinnell Hardness Number |
| CMU | concrete masonry unit |
| CFR | Code of Federal Regulations |
| dBA | decibels, A-scale |
| FL | firing line |
| Grain | the weight of gunpowder in ammunition |
| GSA | General Services Administration |
| GWB | gypsum wall board |
| HEPA | high efficiency particulate air |
| HVAC | heating, ventilating, and air conditioning |
| IESNA | Illuminating Engineering Society of North America |
| $\mu\text{g}/\text{ft}^2$ | micrograms per square foot |
| $\mu\text{g}/\text{m}^3$ | micrograms per cubic meter |
| NIOSH | National Institute of Occupational Safety and Health |
| OSHA | Occupational Safety and Health Administration |
| PA | public address |
| PEL | Permissible Exposure Limit |
| PLC | programmable logic controller |
| PPE | personnel protective equipment |
| ppm | parts per million |
| PSI | Pound per square inch |
| RSO | Range Safety Officer |
| STC | Sound Transmission Class |
| TLV | Threshold Limit Value |
| TWA | time-weighted average |
| USEPA | United States Environmental Protection Agency |

INDOOR FIRING RANGE DESIGN, OPERATIONS AND MAINTENANCE CRITERIA

1.0 INTRODUCTION

The following criteria for the design and operation of indoor firing ranges (IFRs) within General Services Administration (GSA) owned property was compiled to identify a set of regulations, standards, and principles to guide the design, evaluation, retrofit, and management of both existing and new firing ranges. Provided in this guidance are criteria for range layout, ballistic protection, ventilation controls, acceptable noise levels, desired lighting, and standards for operation and cleaning/maintenance of the range and its components.

This guidance is a resource not only for GSA but for building managers, agencies using the range, and operations personnel that have a stake in providing a safe and proper facility for firearm training. It is not intended as a stand-alone document for design, evaluation, or operation of a range. Rather these requirements are to be integrated into other construction, operation, and maintenance plans such that the overall operation of a range is efficient and safe.

The presented criteria are based on sources as noted in Section 4.0 and on GSA-specific operating and maintenance experience, which together provide generally accepted industry standards aimed at providing a safe and healthy environment for shooters, range officers, and cleaning/ maintenance employees as well as other building occupants, visitors, and members of the public in and around firing range facilities. The criteria identified in this guidance provide general information to assist GSA and range users in recognizing and controlling safety and health hazards. The listed criteria include those requirements identified in a specific federal statute, industry standards employed at other range facilities, and GSA practice or standards (both regional and national). A properly designed and operated range provides a benefit to the users, building owners, occupants, and the overall community.

Use of these criteria in evaluating or retrofitting an existing range (or in the design of a new range) should only be done under the guidance of personnel experienced in both range design and industrial hygiene. This is particularly true in applications to existing ranges where conformance to all the criteria may not be necessary to meet regulatory and safety requirements.

Firing ranges should be periodically evaluated against these criteria to determine if changes in operations, maintenance or design are necessary to meet the applicable criteria and safety requirements.

1.1 Firing Range Basics

Indoor firing ranges allow for the controlled discharge of small firearms. Most are designed for pistols and shotguns, and some may be suitable for rifles. They generally consist of multiple firing lanes allowing a number of shooters to use the facility simultaneously from a number of shooting positions. Targeting systems are provided for each lane.

The range is designed to dissipate the energy of the projectiles discharged and protect shooters from errant shots or misfires. To this end, the range is provided with floors, walls, baffles and a bullet trap capable of dissipating the energy of the most powerful round allowed at the range. The range is equipped with a ventilation system to keep harmful gases, fumes, and dust (primarily lead) created during firing from impacting the shooters or leaving the range to impact others outside the range. A range safety officer (RSO) is provided a room from which to oversee the activity at the range, as well as monitor and control the mechanical ventilation and electronic systems at the range.

Each range also has in place a number of policies and procedures for shooters and cleaning/maintenance staff aimed at keeping the range in good working condition, recycling spent rounds and casings, and preventing lead accumulation inside the range (and the possible movement of lead dust outside the range).

1.2 Safety and Compliance

The paramount consideration in the design and operation of any indoor firing range is the need to provide a safe and healthy working environment. This includes providing adequate ballistic protection for the firearms used at the facility, and sufficient protections for shooters, range officers, and other building occupants so that exposures to lead, gases, and other toxins related to firearm discharge remain at levels that are safe.

Of necessity, range operation requires the education and training of all range users and employees on the guidance and procedures that allow for safe operation of the range. Enforcement of those procedures, as well as periodic monitoring are necessary program elements.

Periodic and regular inspections and evaluations of operating ranges shall be conducted to promote compliance with safety and health requirements. The criteria presented in this guidance should also be periodically reviewed and updated to include the latest safety and operating guidelines for indoor ranges.

In the event of non-compliance with these criteria, response measures should be considered and implemented. Simple changes related to procedural or administrative issues can be easily implemented at the direction of the RSO, the using agency or the building manager. Non-compliance issues related to exposure or design changes at the range should be discussed with GSA Regional environmental and industrial hygiene personnel. Administrative

limitations regarding range use may need to be implemented or in severe cases, the range may be shut down pending corrective measures.

2.0 DESIGN CRITERIA

The range evaluation criteria listed in this guidance are derived from authoritative sources on the design, operation and maintenance of indoor firing ranges. These sources are listed in Section 4.0, List of References; Appendix A provides a summary of the information obtained from each of the referenced source guidance documents.

Table 3 provides a summary of the IFR criteria. Each cited criterion noted in this table is accompanied by a label indicating whether the criterion is: (1) a regulatory requirement (meaning a specific federal statute applies), (2) an industry standard taken directly from another information source, or (3) a GSA practice developed for this specific document. In cases where multiple documents reference the same requirement the most applicable is referenced.

The range evaluation criteria listed in this guidance have been developed assuming that the indoor range utilizes a fixed firing line. This means that no tactical training takes place in these facilities that requires shooters to move throughout the facility beyond the fixed firing line. (Note: Tactical training requires a different set of criteria for ballistic design as well as additional measures to provide protection from exposure to lead and other toxins. Requirements for tactical training should be referred to GSA Regional environmental personnel.)

Note that other requirements beyond those identified in this guidance may apply to the design, operation and maintenance of a specific range. Examples include specific state and local regulations, as well as fire protection and security requirements specific to a location or building, as is set forth in 40 USC Sec. 3312.

2.1 General Range Layout

2.1.1 Dimensions

Typical distances from the firing line to the target line are from 75 to 85 feet (no standard distance is required). In addition, the range shall: (1) provide a minimum of 10 feet from the air supply plenum to the firing line (see 2.4.3), (2) a RSO control room, and (3) a minimum of 20 feet behind the target line for the bullet trap. Figures 1 and 2 provide a typical cross section and plan view of a range.

2.1.2 Firing Line

The firing line shall be clearly visible and marked with a minimum 4-inch wide red line running across the floor from wall to wall. A signal to alarm whenever someone crosses the firing line shall be required (see 3.4).

2.1.3 Shooting Lanes

Designated lanes, stalls or stations shall be marked and labeled for shooters. This may consist of painted marks, or full or partial partitions. Partitions shall present a minimal profile to promote adequate ventilation. The minimum width for the each shooting lane is 4 feet. At the range walls (along the firing line), a separate unused lane with a minimum width of 1 foot shall be in-place or the stations adjacent to the walls shall be a minimum of 5- feet wide (see Figure 2). This is to limit the impact of the walls on the flow of air and thus improve airflow and protection for the shooters). Stations are to be numbered for easy identification by shooters and the RSO.

2.1.4 Openings and Egress

General access to the range for users and visitors shall be through a two door air lock type enclosure (i.e. two separate doors that are both sealed to minimize air flow). All doors shall open outward from the range. No windows or doors are allowed downrange of the firing line. A single door for maintenances purposes may be acceptable for access to the bullet trap if the door is sealed properly, is normally locked, opens outward from the range, and has an alarm to shut the range down if opened.

2.1.5 Range Safety Officer Control Room

A separate RSO control room shall be provided with a minimum size of 8 x 10 feet. A window shall be provided with clear visibility to all shooting lanes and downrange to the target area. Windows shall be made of tempered glass. Ventilation in the room shall be separate from that provided for the range. A table or shelf shall be provided for all controls, alarms, lighting, and communication for the range.

2.1.6 Target Retrieval System

Each range shall employ a target retrieval system that eliminates the need for personnel to go beyond the firing line during normal operation.

2.1.7 Support Facilities

Each range shall be equipped with adjacent washing facilities that require range users to pass by when exiting the range. Shooters shall be required to wash their hands and face after each session. An emergency eyewash station shall also be provided at this wash area. A dedicated locked storage area for range cleaning materials and recyclable wastes shall be provided. A drinking fountain and sanitary facilities are also desirable.

A designated weapons cleaning area shall be provided. The area shall be separate from the RSO control room and range, located adjacent to the washing facilities noted above, and shall not be used for other purposes such as a classroom or break room. The area shall have forced ventilation aimed at minimizing solvent odors and dust. Tables or benches shall be provided that are resistant to cleaning solvents. A locked storage cabinet shall be provided for

cleaning materials. The weapons cleaning area shall be cleaned at the same frequency as the range using the same procedures.

2.2 Ballistic Design

The ballistic performance of walls, floors, and ceilings, is a function of their ability to redirect small caliber rounds downrange without penetration and ricochet. Each range shall be equipped with walls, floor, ceiling, baffles, and a bullet trap sufficient to contain and absorb the energy from the most powerful ammunition used at the range. Potential avenues for a misfire or ricochet to leave the facility shall be sealed. Indoor ranges are designed for use of handguns firing both lead and ball ammunition up to and including .357 magnum, cal. 45 automatic and 9 mm. Rifle cartridges should normally be limited to cal .22 rimfire. The use of armor piercing ammunition is prohibited.

All surface areas shall be as free as possible of any obstructions and protrusions into the range area and are to be flush as possible for their entire length. Ceiling space shall be void of utilities, exposed wiring and protruding structures.

Cross range firing is not anticipated nor planned for this range configuration, and, therefore, direct hits fired at angles less than forty-five (45) degrees to the surface will not occur. It is important that the floor, wall, and ceiling finishes be capable of redirecting projectile energy.

Obstructions are unavoidable. Target lighting, utilities in the ceiling space, or soffits of beams framing floors above, or columns in walls which protrude beyond the face of a wall, require ballistic protection. Ceiling baffles, wall flaring, redirective guards, and horizontal air space ceilings are used for this purpose.

2.2.1 Floors

Each range floor shall consist of level reinforced concrete (minimum 100 mm) with a smooth unobstructed surface coated with a waterproof surface sealant that provides for easy cleaning. No floor drains are allowed. Indentations and ruts in the floor shall be repaired and resealed. The floor PSI strength and thickness required shall be determined depending on ammunition in use and the occupancy of space below the range floor. Requirements shall be determined on a facility specific basis.

2.2.2 Walls

Walls shall consist of reinforced concrete or 200 mm fully grouted reinforced masonry block (CMU). A coating is not recommended so the concrete will provide some sound attenuation. If this type of concrete wall is not present, steel wall protection is required at the levels mandated for baffles. At a minimum, the top of the wall shall extend to the top of the overhead baffles and the wall shall extend to a minimum of 5 feet behind the firing line. Wall thickness is dependent on the ammunition used and the construction material used and specific requirements will be determined on a facility specific basis.

Side Containment or Sidewalls

Sidewalls are required to prevent direct fire from exiting the range. Finished elevation of a sidewall must be above the top edge of the highest overhead baffles. Each sidewall must be at least 5 feet (1.52 meters) from the outside edge of the firing position limits of fire and extend at least 3.2 feet (1 meter) to the rear of the firing line. Sidewalls may be made of fully grouted reinforced masonry block (CMU), reinforced concrete, or hardened steel.

Continuous Walls

Vertical smooth-faced walls constructed of reinforced concrete, CMU with fully filled cores, or hardened steel may be used for sidewalls.

Walls will extend 3.2 feet (1 meter) behind the firing line to prevent a bullet fired parallel to the firing line from leaving the range.

Design these walls for all dead and live loads, including lateral forces.

Address noise reduction requirements (Refer to Section 2.4 - Noise Reduction and Range Acoustics). Walls will extend 3.2 feet (1 meter) behind the firing line to prevent a bullet fired parallel to the firing line from leaving the range.

2.2.3 Ceilings

The ceiling over the range will be covered with a protective shield suitable for the most powerful cartridge authorized for range use. This canopy baffle (safety canopy) shall extend a minimum of 12 ft (3.66 m) in front of the firing line and 3 ft (0.914 m) behind the firing line. Baffle shall be horizontal to minimize disturbance of the airflow across the firing line. The canopy baffle shall be equipped with splatter protection, consisting of a minimum 1½ inch air space and fire-rated plywood sheeting on the face of the baffle. Acoustical tile shall be applied to the plywood sheeting for sound transmission deadening. Other materials and designs may be considered if approved by GSA.

The canopy baffle requires sealing of all openings to isolate the range from the surrounding areas for purposes of ventilation, ricochet protection and acoustic sound transmission. On existing ranges, the openings in the ceiling shield for lighting, ventilation and the target carrier mechanism shall be kept to a minimum. The remainder of the ceiling from the end of the safety canopy to the bullet trap shall be protected with a ceiling baffle system to protect overhead projections, joists, electrical and mechanical systems.

All target lighting and other ceiling mounted utilities must be protected by additional baffles as required. All plywood must be fire-treated to achieve an ASTM E84 Class I flame spread rating.

Overhead baffles extending down range shall be present to eliminate any 'line of sight' openings to the ceiling from any shooting position on the firing line (see Figure 1). These baffles shall be oriented at a 12 to 42 degree angle to the

ceiling, with the high end of the slope toward the firing line. The baffle spacing shall be such that it provides "line of sight" protection for all lighting and utilities. The top of the baffles shall extend at least 6 inches beyond the "line of sight" from the lowest firing position at the firing line (see Figure 1).

All overhead baffles within 50 feet of the firing line shall provide splatter protection. Baffles shall consist of AR500 plate steel with a thickness dependent on the ammunition used. Other commercially available baffle material and thicknesses may be used, if warranted by the manufacturer for use with the ammunition types employed at the range, and if approved by GSA environmental personnel. Deformation or penetration of the baffles shall be repaired.

2.2.4 Bullet traps

Each range shall contain a commercially available bullet trap installed capable of handling the highest powered ammunition used at the range. The trap shall be in good working condition and undergo maintenance, inspection and cleaning as recommended by the manufacturer. Significant deformation, damage or perforations to the trap shall be repaired. The trap shall be attached to the building structure with an energy absorbing anchor aimed at reducing noise and vibration. Newly installed bullet traps shall be designed to capture whole slugs and minimize maintenance to recover the slugs. New traps shall not use dirt, sand, or rubber granules to dissipate energy and capture rounds. As a guide for bullet trap construction refer to Appendix B – Ballistic Safety References; Minimum Steel Plate Thickness for Metal Backstops, Deflector Plates, and Bullet Traps.

2.3 Ventilation

2.3.1 Air Flow through Range

Design air flow at the firing line shall average 75 ft/min (feet per minute) plus or minus 10%. Air flow readings taken at shooters breathing zone levels for typical firing positions shall read no lower than 50 ft/min for each range shooting lane. Smoke tests at the firing line shall exhibit laminar flow to downrange locations. Lingering smoke or smoke that moves up range into a shooting stall shall require evaluation of corrective measures. The minimum air flow downrange of the firing line is 30 ft/min.

New systems shall be purge flow (once-through) systems only, unless recirculation is approved by GSA environmental personnel. Approval is contingent upon demonstrating significant engineering solutions to maintain lead dust levels within established regulatory standards. Existing recirculation systems will be allowed if they conform to the airflow requirements and are instrumented to detect operation outside of design parameters. Heating and cooling shall be provided to the supply air as necessary, considering the range location, and as agreed to with the building manager and RSO.

2.3.2 Negative Pressure

Systems shall exhaust between 7 and 10% more air than supplied and keep the range at a minimum negative pressure of 0.03 inches H₂O.

2.3.3 Supply Plenums

Air supply distribution plenums shall consist of either a perforated wall or a radial diffuser, located a minimum of 10 feet behind the firing line (15 feet is preferred). New installations shall incorporate a radial diffuser.

2.3.4 Ducts

Duct work on the supply and exhaust side of the system shall be symmetric to enhance consistent air flow throughout the system. Non-symmetrical existing systems will be allowed if air flow and exposure levels are within criteria

Exhaust from the range shall be preferentially collected at the bullet trap to minimize dust migration to other locations in the range. Exhaust duct velocities shall be maintained at a minimum of 2000 ft/min upstream of the high efficiency particulate air (HEPA) filter to entrain dust.

2.3.5 Supply/Exhaust

The outside air inlet shall be located a minimum of 15 feet away from the outdoor range exhaust. The exhaust shall also be located a minimum of 15 feet away from areas of public access.

Exhaust air concentrations shall meet EPA ambient air criteria for lead with a maximum allowable concentration of 1.5 ug/ m³ airborne lead.

2.3.6 Air Controls

Air supply and exhaust fans shall be interlocked and instrumented such that they shall simultaneously be in operation to allow use of the range. The interlock shall shut off both systems if either is not working and set off an alarm. Interlocks shall be timed to start the exhaust fan first so as to avoid a positive pressure within the range. An interlock shall also be provided to alarm and shut down the system if the range pressure goes positive for more than 2 minutes. An alarm across the HEPA filter shall be present to notify the RSO that the system is in need of maintenance.

Digital control systems utilizing programmable logic controllers (PLCs) shall be used for the interlocks and controls. Existing facilities may rely on analog systems if they can be retrofitted in an economic manner to accommodate the necessary interlocks and alarms. (GSA standard)

2.3.7 Filters

Supply air shall be filtered before conditioning. Exhaust air shall undergo pre-filtration with final filtration using HEPA filters. At facilities where a 'clean trap' (a trap that is designed to minimize the fragmentation of the slug) is used, 2 stage (pleated filter, HEPA filter) filtration of the exhaust is acceptable. Where another

type of trap is used 3 stage exhaust filtration (pleated filter, bag/cartridge filter, HEPA filter) is required.

2.4 Noise

2.4.1 Reduction

Noise reduction within the range and noise transmission out of the range are different design considerations. Mass and limpness are two desirable attributes for sound absorption. Unpainted heavy masonry walls provide mass. Absorptive acoustical surfacing will reduce the noise level in the range but have little effect on transmission outside the range.

2.4.2 Ambient Noise

Ambient noise levels, including the ventilation system noise, at the firing line should not exceed 85 decibels, A-scale (dBA), and should be considerably less to improve communication between shooters and the range official.

Short duration noise such as gunfire will exceed the 85 dBA level and may be as high as 160 dBA. The range design must prevent the reflection of these higher noise levels by using sound-absorbing materials where possible.

2.4.3 Acoustical Treatment

Use acoustical treatment on surfaces behind the firing line. Floor areas behind the firing line may be covered with acoustic material (rubber mats) if it will not impede heavy metal dust removal.

Do not paint downrange walls or acoustic tile, since paint significantly degrades the sound-absorbing qualities of the materials. Existing ranges may continue using painted surfaces. Special sound-absorbing concrete blocks are available that reduce the noise in the range.

Perimeter range walls shall have a double wall construction with core-filled concrete masonry unit (CMU) wall to structure on the inside for ballistic protection and 2 layers gypsum wall board (GWB) on metal stud on outside face with acoustical insulation for acoustical separation.

Acoustic panels no larger than 1200 millimeters (47 inches) wide may be installed on walls and ceilings in the firing line area. Blown-on acoustic material and carpeting are not permitted due to the difficulty of cleaning accumulated heavy metal dust.

Noise levels outside the range shall not exceed 85 dBA. Lower noise levels may be required depending on the specific uses of adjacent areas.

2.5 Lighting

Downrange lighting (both red and white light) shall be designed in accordance with the IESNA Lighting Handbook to provide for safety and housekeeping operations as well as general range illumination. Light intensity at the target face should be 914 to 1076 lux (85 to 100 foot-candles) measured 1200 millimeters (47 inches) above the range surface at the target face. Provide a minimum of 322 lux (30 foot-candles) for white light general range illumination and 107 lux (10 foot-candles) for red lights.

Lighting shall be provided by multiple banks of lights arranged behind overhead baffles along the length of the range. Lighting banks shall be provided to illuminate standard training distances. These are generally 3, 5, 10, and 25 yards downrange. Other distances may be approved specific to a firing range and target system. Provide controls to vary lighting intensity throughout the range to accommodate subdued-light training requirements. Controls for all lighting will be operated from the RSO control room. Flashing red and blue lights at the firing line and downrange can be provided to simulate emergency situations.

3.0 OPERATIONS AND MAINTENANCE CRITERIA

All range firing sessions shall be conducted under the direction of an RSO. Signage shall be provided and procedures posted for all shooters. No access shall be allowed in front of the firing line except for cleaning or maintenance. The area behind the firing line and in front of the supply plenum shall be kept free of stored materials so as not to interfere with proper air flow.

3.1 Facilities Cleaning

A site specific range cleaning plan shall be documented for each facility. It shall address, at a minimum, the required qualifications for cleaning personnel, the equipment to be used, surfaces to be cleaned both in the range and in support areas, procedures for cleaning all surfaces both during routine and comprehensive cleaning, and disposal and handling of all wastes.

The cleaning procedures and plan shall incorporate the following requirements:

- Routine range cleaning shall be done, at a minimum, every day the range is in operation. Routine cleaning shall include emptying spent slugs from the bullet trap and cleaning all horizontal surfaces within the range.
- Post ventilation system maintenance cleaning shall be done whenever filters are replaced or maintenance is performed on the exhaust system. Post maintenance cleaning shall include cleaning all horizontal surfaces within the range, and cleaning of all heating, ventilating, and air conditioning (HVAC) areas.
- Comprehensive cleaning shall be done, at a minimum, once a year and include cleaning of all surfaces both within the range and in the support

facilities. Wipe tests shall be conducted to verify the effectiveness of this comprehensive cleaning.

- Brass shell casings shall be gathered daily and collected using a dedicated wooden or plastic rake for the purpose that minimizes collection or stirring up of lead dust.
- Cleaning shall be done in a sequential manner to minimize the spread of dust.
- The ventilation system shall be on during the cleaning. All cleaning personnel working behind the firing line shall wear a respirator with cartridges designed for removal of lead dust (use cartridges that can be processed for lead recovery, if possible).
- All range cleaning equipment shall be dedicated to use at the firing range only, and not be used in cleaning any other area of the building.
- All surfaces shall be cleaned using disposable cloths wetted to retain dust (swiffers™). Use of vacuums, brooms, compressed air or water sprays are prohibited.
- Equipment for cleaning the range and support areas shall be used only for the range and no other areas of the building.
- Cleaning personnel shall be trained and certified in accordance with regulatory lead hazards and applicable local cleanup requirements.

3.2 Signage

Signs shall be posted reminding shooters of restrictions and requirements. This shall include:

- A sign indicating the highest powered ammunition allowed at the range
- A sign reminding shooters that no personal effects, alcohol, tobacco, food or gum is allowed in the range
- A sign requiring the use of hearing and eye protection.
- A sign on the door to the trap area indicating the area as hazardous
- A lighted "*range in operation*" sign or sign with flag
- A sign prohibiting the storage of materials between the firing line and plenum
- A sign reminding shooters to wash their hands and face after a session
- A sign prohibiting weapons cleaning except in the designated area
- Range Operating Procedures

Procedures shall be written and posted outside the range and copies made available to all shooters. All shooting stalls shall be numbered and correspond to the target numbering used.

3.3 Communication

A written summary of range procedures applicable to shooters shall be prepared, provided to the GSA property manager, the RSO's and made available to all shooters. Training sessions shall be held at least annually to familiarize all shooters with the procedures.

A public address (PA) system operated from the RSO control room shall be in operation to communicate with shooters at the firing line.

3.4 Alarms

The following interlocks shall be provided to trigger an audible alarm at the firing line and dim the lights throughout the range

- A laser or infrared trip at the firing line
- An open door to the range
- Interlock trip on the ventilation
- Manual shutdown in the RSO control room
- Someone crosses the fire line

The ventilation system shall remain operative unless the alarm is caused by a ventilation system malfunction.

3.5 Inspection and Testing

At least once every two years the range shall undergo comprehensive inspection, testing and evaluation for adherence to the following criteria: When any major facility upgrade, ammunition upgrade, remodeling, or replacement of equipment is done the range shall be evaluated. The inspection shall be documented and kept on file. Measured air flows, ventilation performance, noise levels, lighting intensities, airborne lead levels, and adherence to proper cleaning and maintenance procedures shall be documented.

3.6 Exposure

All shooters shall wear approved hearing (NIOSH method #1B1) and eye protection (ANSI Z87.1) as mandated for the facility that meets applicable OSHA and industry standards. (Reference 9)

3.6.1 Hearing Conservation

Hearing protection for shooters will provide protection against this noise. A warning sign at the Firing Line indicating, "Noise Hazard - Double Hearing Protection Required" shall be required. Personnel should be trained to ensure proper fitting of hearing protection devices and determine the incompatibility with other protective equipment, such as safety glasses.

Evaluate the noise exposure of Range Safety Officers (RSOs) to determine total noise dose and whether exposures exceed the OSHA Action Level of 85 dBA and the OSHA PEL of 90 dBA for an 8-hr time-weighted average (TWA).

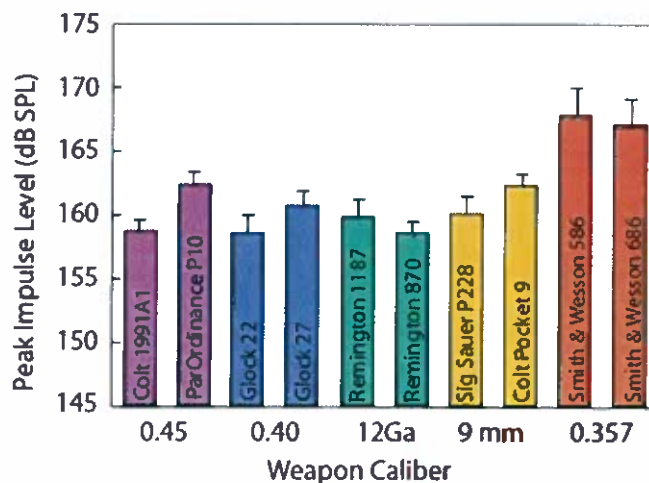
The OSHA Occupational Noise Exposure standard (29 CFR 1910.95) has an action level of 85 dBA, which states that an employer must administer a continuing, effective hearing conservation program when the 8-hour TWA noise exposure equals or exceeds the action level. The program must include exposure monitoring, employee notification, observation, an audiometric testing program, hearing protection, training programs, and maintenance of records. The

standard also states that when workers are exposed to noise levels in excess of the OSHA PEL of 90 dBA (8-hour TWA), feasible engineering or administrative controls shall be implemented to reduce workers' exposure levels. In addition, noise generated from weapons is classified as impulse noise. The OSHA standard states that exposure to impulse noise should not exceed 140 dB sound pressure level (SPL).

NIOSH case studies of indoor firing ranges indicate the use of double-hearing protection is effective to ensure maximum protection against impulsive noise.

The subject NIOSH case studies illustrate the need to assess impulse noise exposure correctly by using proper sound measuring instruments and techniques, and the importance of using double hearing protection while shooting as part of an overall hearing conservation program.

The NIOSH case studies indicated earplugs with earmuffs had a peak reduction of 18 dB. The mean peak reduction for earmuffs was 26 dB, while earplugs alone provided a mean peak reduction of 24 dB. The mean peak reduction for the combined earmuff and earplugs was 44 dB.



Peak noise levels from various small firearms.

Table 1 Peak Noise Levels from various small arms. (DHHS, 2009)

3.6.2 Airborne Lead within Range

Federal regulations promulgated by OSHA (29 CFR 1910.1025) in 1978 dictate that the permissible exposure limit (PEL) to airborne lead in the workplace be limited to 50 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) as a time-weighted average (TWA) over an 8-hour workday. An action level of 30 $\mu\text{g}/\text{m}^3$ is also referenced. Design criteria for indoor firing ranges should be based on the action level of 30 $\mu\text{g}/\text{m}^3$ airborne lead exposure. Per 29 CFR 1910.1025, worker protection from lead and the requirements for training, personal protection, engineering controls

and medical surveillance are based on exposure as an 8-hour time-weighted average (TWA). Administrative controls (i.e. limiting the time personnel are in the range actively firing) may be based on the measured exposure. From a regulatory perspective, non-firing (unsampled) periods are assumed to be zero lead exposure unless the worker is performing some activity to cause potential exposure (this should be part of the sampled period).

To limit personnel exposure below the action level of $30 \mu\text{g}/\text{m}^3$ limitations on firing operations may be computed using the table that follows.

| Exposure Based | |
|---|--|
| 30 $\mu\text{g}/\text{m}^3$ criterion = | $\frac{(\text{measured exposure concentration}) \times (\text{acceptable time})}{8 \text{ hours}}$ |
| Example - if the measured exposure during firing was $0.15 \text{ mg}/\text{m}^3$ ($150 \mu\text{g}/\text{m}^3$) | |
| 30 $\mu\text{g}/\text{m}^3$ criterion = | $\frac{(150 \mu\text{g}/\text{m}^3) \times (\text{acceptable time})}{8 \text{ hours}}$ |
| Acceptable time = 1.6 hours | |
| 1.6 hours at $150 \mu\text{g}/\text{m}^3$ will expose the worker to less than $30 \mu\text{g}/\text{m}^3$ TWA for the entire work day (including the firing period) | |

Table 2 Calculating Lead Exposure

Periodic industrial hygiene testing and inspection are intended to maintain range performance relative to this regulatory standard (see section 3.5).

Airborne lead levels at the firing line during live fire exercises shall not exceed $30 \mu\text{g}/\text{m}^3$. Exceedances will trigger monitoring and medical surveillance of personnel deemed to be at risk due to the time spent on the range as determined by the RSO and GSA environmental personnel. Airborne lead levels that exceed $50 \mu\text{g}/\text{m}^3$ will trigger administrative limits on the time and by whom the range can be used and may also trigger a determination by GSA authorities to shutdown the range. In this instance, revisions to the range design and ventilation will also be considered.

3.6.3 Lead Dust

Lead dust levels as measured from wipe samples according to ASTM E1728-03 taken behind the firing line, and in support areas adjacent to the range (including training, storage and HVAC maintenance areas) shall be less than $200 \mu\text{g}/\text{ft}^2$. Other more stringent standards may be applied by GSA environmental personnel in areas outside the range where the general public has access, as necessary to limit exposure in those areas.

3.6.4 Carbon Monoxide

Carbon monoxide (CO) exposure levels shall be less than the OSHA 8-hr TWA PEL established in 1971 of 50 ppm (parts per million) with a targeted goal of 25 ppm which is the 2011 ACGIH threshold limit value (TLV).

3.6.5 Hygiene

Sticky mats shall be provided at the range exits for wiping feet prior to leaving. Sticky mats shall also be provided at maintenance egress where lead dust may be present. No food, alcohol, tobacco, or personal effects are to be carried into the range. Only government approved firearms and ammunition shall be allowed to be carried on the range. Each range shall be equipped with adjacent washing facilities that require range users to pass by when exiting the range. Shooters shall be required to wash their hands and face after each session.

3.7 Waste Management

All brass and lead wastes shall be kept separate and stored in dedicated 2 to 5 gallon sealable buckets labeled "Brass only" and "Lead only". These buckets shall be utilized only for wastes from the firing range. When not in use these containers shall be closed and locked in storage.

Brass and lead wastes shall be weighed and the amount of lead or brass collected shall be logged daily.

3.7.1 Recycling

All suitable recovered brass casings as well as all recovered lead slugs and lead impregnated wastes shall be collected and recycled. "Brass only" wastes shall consist of brass shell casings retrieved from the range. Lead wastes shall include all spent disposal cleaning materials, personnel protective equipment (PPE), spent shells and HVAC filters. Recycling of these items shall be conducted in strict adherence to regulatory requirements.

These wastes shall be periodically recycled as necessary at a previously identified and approved licensed recycling facility. The recyclable wastes shall be weighed at the recycling/reclamation facility and the weight shall match the running daily total of waste generated at the range.

3.7.2 Hazardous Waste

"Lead only" wastes not sent for recycling shall be properly characterized in accordance with the Resource Conservation and Recovery Act (RCRA), and managed in accordance with hazardous waste storage, labeling and disposal requirements unless testing proves otherwise.

3.8 Recordkeeping

3.8.1 Activity Records

A sign-in sheet or log of personnel using, visiting or working at the range shall be maintained. At a minimum, the dates, time, and name of each individual that

enters and exits the range shall be documented along with the purpose of the range visit (training session, RSO, etc.) All shooters shall also record the type of ammunition used and the number of rounds fired.

A maintenance log shall be maintained for the facility to record when range cleaning, trap maintenance or ventilation maintenance is performed and by whom. The log shall record the type of work done, the duration, the personnel involved and any unusual events.

Other pertinent record shall include the following:

- A log of all recycled materials and wastes generated and removed from the range.
- All waste sampling results and shipping documents.
- Inspection, testing, and evaluation results.
- A site specific range cleaning plan.
- A site specific maintenance plan shall be documented for each facility maintenance plan.

3.8.2 Maintenance Plan

Each site-specific facility maintenance plan shall address, at a minimum:

- Regular periodic inspection and repair of signage, lighting, targeting systems, storage areas, and cleaning facilities associated with the range
- Regular periodic inspection of the ventilation system intake, distribution system, and exhaust, including measurement and verification of key parameters such as flow, pressure, and filter pressure drop
- A maintenance schedule for all mechanical equipment associated with the range
- Verification that alarms are working properly
- Regular periodic inspection and repair of the bullet trap, floor, walls and baffles to provide ballistic integrity
- Procedures for HVAC filter inspection and replacement with specific provisions for minimizing lead dust exposure and release during filter replacement and disposal
- Procedures for the comprehensive inspection and testing as noted within this criterion document.
- Documentation procedures for recordkeeping and maintenance activities
- Waste handling, recycling and disposal procedures.
- A sample range sign-in log.
- A sample maintenance log.

3.9 Limitations

The presented criteria are intended to be used as guidance for evaluating, designing, operating, and the management of indoor firing ranges in accordance with applicable safety and health standards. They have been derived from similar criteria established by US government agencies for design and operation

of indoor firing ranges as well as the operating experience of GSA in managing existing ranges. When followed, this guidance provides a basic framework for a safe and healthful environment both inside and outside the range. These criteria should be updated as new technologies and guidance become available related to the operation of indoor firing ranges.

It should not be implied that adherence to these criteria warrants a safe and healthful condition as such performance depends not only on the specific design and operating considerations, but also on having properly trained and informed shooters, range employees, and cleaning personnel who are conscientious in their use and maintenance of the range. It should also be noted that deviations from these criteria do not necessarily mean a range is unsafe. Specific adherence to a criterion or impacts from deviations from a criterion should only be determined by qualified personnel experienced in the design and operation of ranges, and in the application of environmental and industrial hygiene aspects to indoor firing ranges.

4.0 LIST OF REFERENCES

1) Small Arms Range Design and Construction, Engineering Technical Letter (ETL) 08-11, Department of the Air Force, HQ AFCEA/CEO, 20 Oct 2008

2) Lead Exposure and Design Considerations for Indoor Firing Ranges, Anania, Thomas and Seta, Joseph, National Institute for Occupational Safety and Health, USDHEW, Dec 1975

Link: <http://www.cdc.gov/niosh/docs/76-130/>

3) Policy and Responsibilities for Inspection, Evaluation and Operation of ARNG Indoor Firing Ranges, National Guard Regulation (NGR) 385-15, Headquarters, Department of the Army and the Air Force, 3 November 2006

Link: <http://www.ngbpdcc.ngb.army.mil/pubs/385/ngr385-15.pdf>

4) Indoor Firing Ranges Industrial Hygiene Technical Guide, Technical Manual NEHC-TM6290.99-10 Rev. 1, Navy Environmental Health Center, May 2002 (New Reference No. NMCPHC-TM IH 6290.10 Rev. 1)

Link: http://www-nehc.med.navy.mil/downloads/IH/indoor_firing_range.pdf

5) Range Safety, Pamphlet 385-63, Headquarters, Department of the Army, April 2003

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6) Draft Design and Maintenance: Small Arms Range Facilities, Unified Facilities Criteria UFC 4-160-01, Department of Defense, March 2002 (superseding MIL-HDBK-1027/3B, 30 June 1995; Military Handbook, Range Facilities and Miscellaneous Training Facilities Other Than Buildings; Section 2: Small Arms Ranges; 2.1: Indoor Small Arms Weapons Ranges)

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No link located for: Draft Design and Maintenance: Small Arms Range Facilities, Unified Facilities Criteria UFC 4-160-01, Department of Defense, March 2002

7) NIOSH ALERT: Preventing Occupational Exposures to Lead and Noise at Indoor Firing Ranges; DHHS (NIOSH) Publication Number 2009-136; April 2009

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8) Toxic and Hazardous Substances, Lead. OSHA 29 CFR 1910.1025

Link:

http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10030

9) Toxic and Hazardous Substances, Air contaminants. OSHA 29 CFR 1910.1000

Link:

http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9991

10) Personal Protective Equipment, Eye and face protection. OSHA 29 CFR 1910.133

Link:

http://osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9778

11) Occupational Health and Environmental Control, Occupational noise exposure.
OSHA 29 CFR 1910.95

Link:

http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=9735

12) Draft Pistol Range Design Guide, United States Marshals Pistol Range
No link located for Draft Pistol Range Design Guide, United States Marshals Pistol Range

13) National Primary and Secondary Ambient Air Quality Standards for Lead 40 CFR Part 50.12 Link: <http://www.epa.gov/ttnamti1/40cfr50.html>

14) IESNA Lighting Handbook Source: The IESNA Lighting Handbook on CD-ROM, 2000, 9th Edition Link: <http://www.ies.org/store/>

INDOOR FIRING RANGE CRITERIA SUMMARY

TABLE 3 INDOOR FIRING RANGE CRITERIA SUMMARY

| <i>Criteria</i> | <i>Regulatory Requirement</i> | <i>Industrial Standard</i> | <i>GSA Practice</i> |
|-----------------------------|---|--|---|
| Exposure | | | |
| Airborne Lead | Exposure less than Action Level for lead of 30 ug/m ³ for 8-hr TWA (5 & 7) | | |
| Lead Dust | | 200 ug/ft ³ action level (4) | |
| Carbon Monoxide | Exposure less than 8-hr TWA of 50 ppm (7) | | |
| General Range Layout | | | |
| Dimensions | | 10 feet between firing line and plenum; minimum 20 feet beyond target line for bullet trap (10) | |
| Firing Line | | Visible and marked (10) | |
| Shooting Lanes | | Marked and labeled. Minimum width for shooting line is 4 feet (5 feet for stations along wall). (4) | |
| Opening and Egress | | Controlled access into range and bullet trap with air lock or other seal type system. Alarm and shut down if range is opened. (4 & 6) | |
| Range Safety Officer Room | | The separation between the Firing Line and RSO Control Room has an STC rating of 55. Vision panel constructed of two panes of glass separated by airspace to achieve highest possible STC rating. RSO Control Room side of the vision panel should be sloping to minimize reflections. Glass panels resiliently mounted to reduce noise transmission. (10) | Separate RSO room with minimum size of 8x10 feet. Equipped with separate ventilation and control system. (6 & 10) |
| Support Facilities | | | Range to be equipped with adjacent washroom and storage facilities. (1 & 4) |
| Ballistic Design | | | |
| Floors | | Concrete with waterproof surface sealant. No drains. (1, 4, & 6) | |
| Walls | | Reinforced concrete or masonry block. (1) | |
| Ceiling | | | Ceiling material not specified. Sealing of all openings required. |
| Baffles | | | Canopy baffle with splatter protection to 12 feet beyond firing line; Overhead plate steel baffles to protect ceiling 'line of sight' with splatter protection to 50 feet from firing line. (1, 4, & 6) |
| Bullet Traps | | Appropriate trap capable of handling the highest power ammunition. Maintain, inspect and clean as recommended by the manufacturer. Appropriate anchor system (1, & 10) | |

Table 3 Indoor Range Criteria Summary

TABLE 3 INDOOR FIRING RANGE CRITERIA SUMMARY CONTINUED

| <i>Criteria</i> | <i>Regulatory Requirement</i> | <i>Industrial Standard</i> | <i>GSA Practice</i> |
|-----------------------|---|--|---|
| Ventilation | | | |
| Air Flow | | | Design air flow of 75 ft/min \pm 10% at firing line. Minimum air flow of 50 ft/min at any position. Minimum downrange air flow of 30 ft/min. Purge flow recommended. (2, 3 & 4) |
| Negative Pressure | | | Minimum negative pressure of 0.03 inches (1 & 6) |
| Supply Plenums | | | Perforated wall or radial diffuser min of 10 feet behind firing line (15 feet preferred). (4) |
| Ducts | | | Symmetrical; Min exhaust duct velocity of 2,000 ft/min to HEPA filter). (6) |
| Supply/Exhaust | Exhaust air lead levels at 1.5 $\mu\text{g}/\text{m}^3$ maximum (7, 8, 9, & 11) | | Adequate separation (min 15 feet) between outside air inlet and exhaust; Exhaust inlet at bullet trap (2) |
| Controls | | | Air supply/exhaust fan interlocks with notification. (2) |
| Filters | | | Pre-filtration of supply air; 2 stage (pre-filtration/final filtration) for exhaust air (1, 2, 3, 4, & 10) |
| Noise | | | |
| Noise Exposure | | Noise levels within the range and RSO room shall not exceed 85 dBA. (1 & 4) | |
| Lighting | | | |
| Lighting Requirements | | Minimum light intensity at the target face 914 to 1076 lux (85 to 100 foot-candles) measured 1200 millimeters (47 inches) above the range surface at the target face. Minimum 322 lux (30 foot-candles) for white light general range illumination and minimum 107 lux (10 foot-candles) for red lights. (1, 4 & 12) | |
| Operations | | | |
| Recordkeeping | | Maintain log for range use and maintenance (6) | |
| Protection | Shooters shall use hearing protection and wear eye protection (2, 8, & 9) | | |
| Hygiene | | Place sticky mats at exists and maintenance egress areas. No food, smoking or other personnel effects are allowed within the range. Wash hands after use. (4 & 10) | |
| Signage | | | Range and adjacent areas shall be placarded with signs identifying range use and restrictions. (3 & 10) |
| | | | |

| <i>Criteria</i> | <i>Regulatory Requirement</i> | <i>Industrial Standard</i> | <i>GSA Practice</i> |
|------------------------|-------------------------------|--|--|
| Communication | | Written and posted procedures for shooters; PA system operated from RSO room (2, 3, & 4) | |
| Alarms | | | Triggered by open doors, ventilation faults, laser trip at firing line (4 & 10) |
| Cleaning | | | Site-specific range cleaning plan; with general range cleaning being performed daily. (3 & 4) |
| Maintenance | | | Written maintenance plan addressing inspection procedures, maintenance of filters, etc. (3 & 4) |
| Inspection/ Testing | | | Comprehensive range review (once per every two years). Collect measurements to assess range performance. |
| Recycling | | | Segregation of waste streams; brass shell casing, lead shot/fragments; filters, maintenance materials and supplies. Lead impacted material not sent for recycling shall be considered a hazardous waste. |

Figures

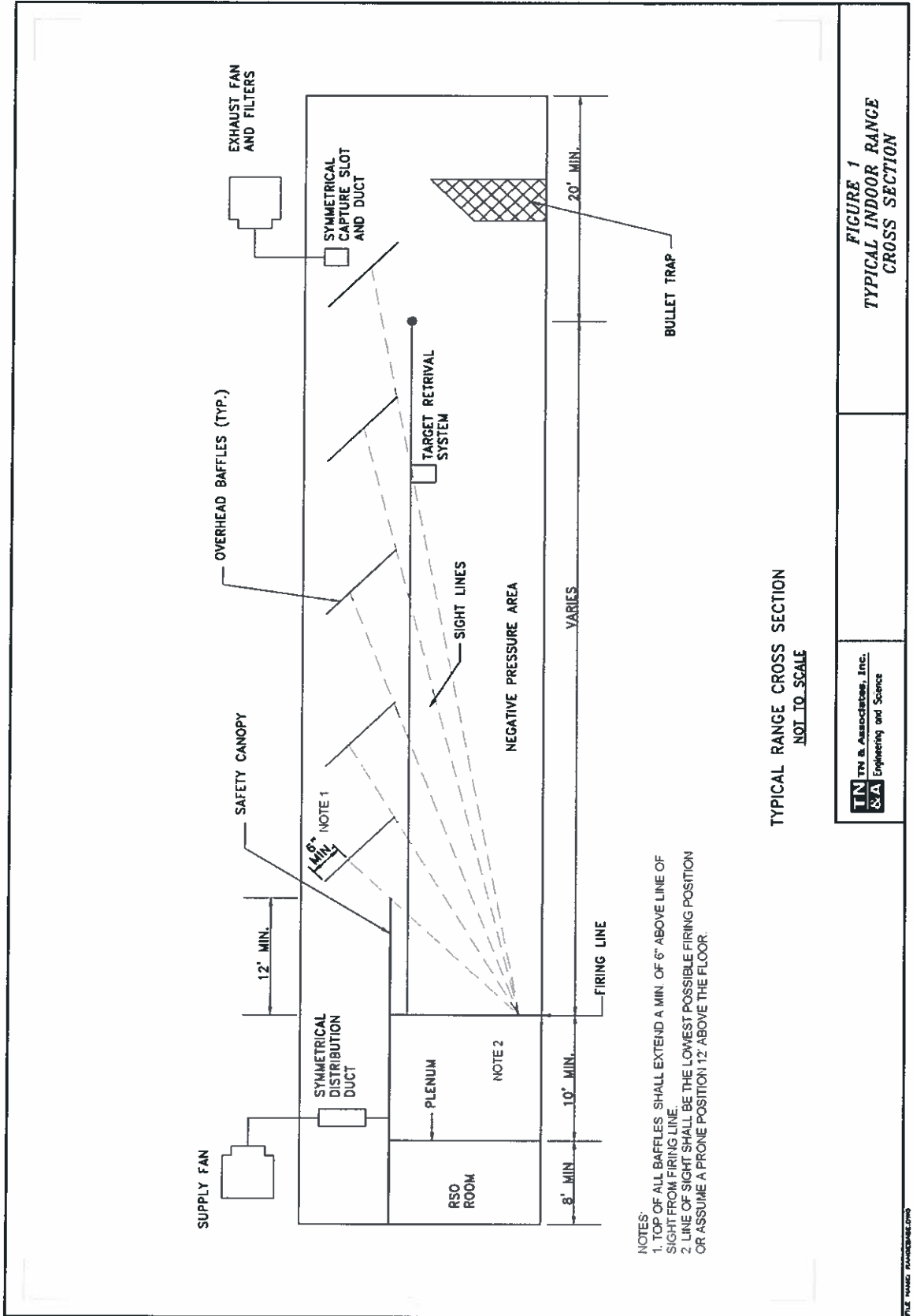


Figure 1 TYPICAL RANGE CROSS SECTION
(Department of the Air Force, HQ AFCEA/CEO, 2008)

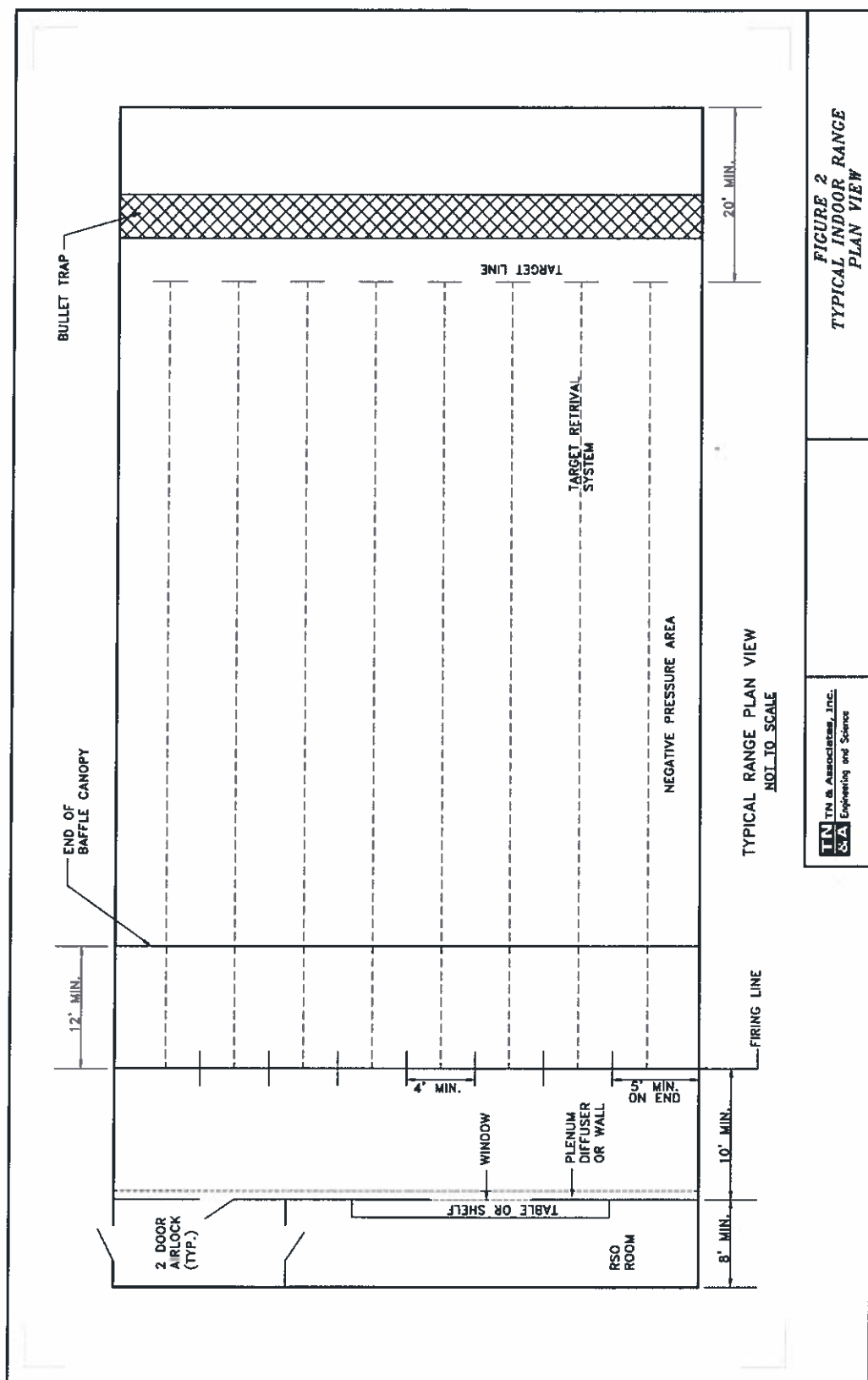
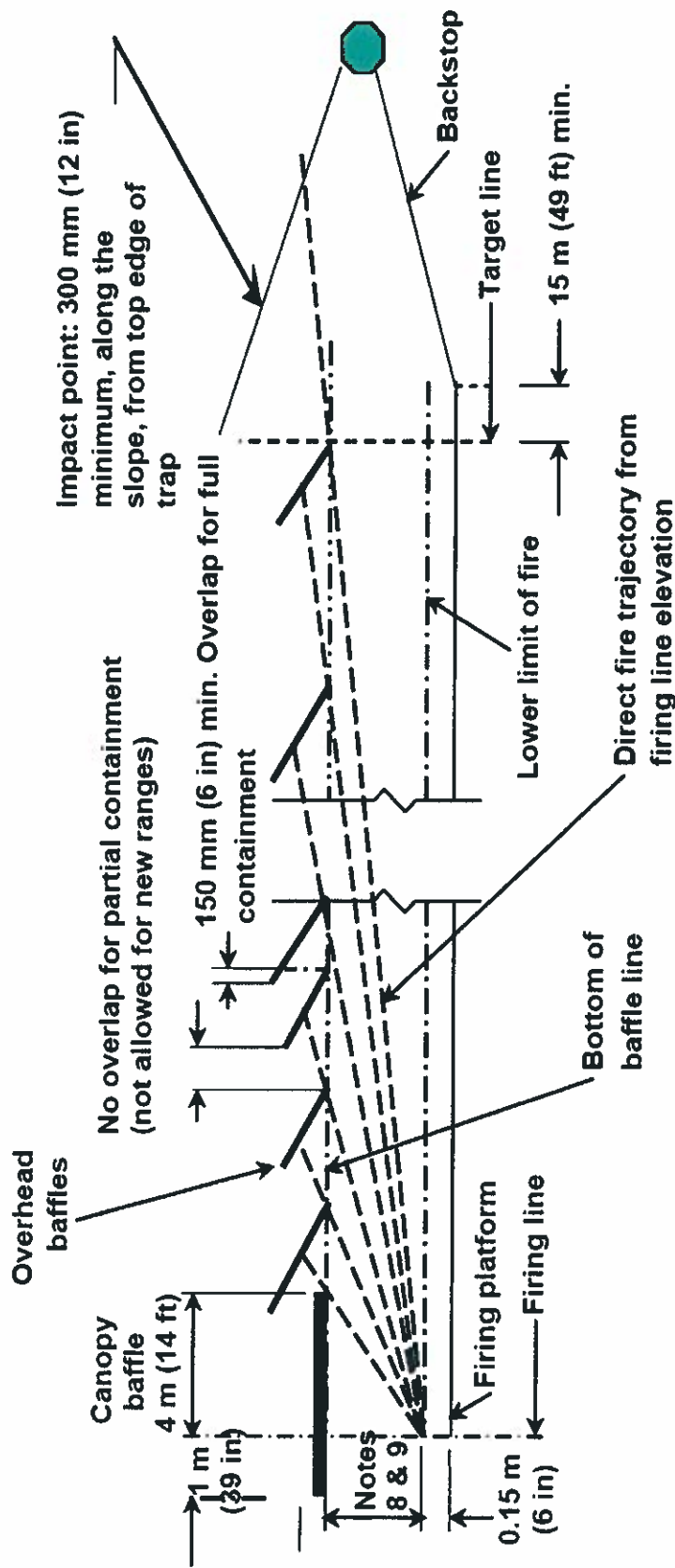


Figure 2 TYPICAL RANGE PLAN VIEW



NOTES:

1. This profile is based on a level range and a fixed firing line.
2. The target distance is established by CA to satisfy the intended training or courses of fire.
3. A tactical, fully contained range will allow shooters to move laterally along the firing line and downrange.
4. Overhead baffles must be angled from 12° to 32° from the horizontal.
5. Fully contained ranges require a 150-mm (6 in) minimum baffle overlap.
6. For existing partially contained ranges, baffles are spaced as required to bring the bullet into the baffle at a point not less than 300 mm (12 in) below the top of the following baffle as measured along its slope.
7. The bullet impact point on the bullet trap is not less than 300 mm (12 in) below the top edge of the trap as measured along the slope.
8. If vehicle access is not required, locate the bottom of the baffles at least 2.45 m (8 ft) above the firing platform.
9. If vehicle access without machine gun pedestal, locate the bottom of the baffles at least 3.68 m (12 ft) above the platform.
10. The canopy baffle may be sloped up to 30 degrees from the horizontal. If sloped, the high point of the canopy is closest to the target line.

Appendix A
Summary of Source Guidance Material

Summary of Source Guidance Material Continued

Summary of Source Guidance Material

| Item | OSHA/EPA References 7,8,9,11 | NIOSH Reference 2 | Army Reference 5 | Navy Reference 4 | Air Force Reference 1 | UFC Reference 6 | Army National Guard Reference 3 | US Marshals Draft Guide -- Reference 10 |
|--|------------------------------------|----------------------|---------------------|---|--|--|--|---|
| Ballistic Design and Layout | | | | | | | | |
| Shooting Stations/Lanes | | | | 5 ft wide preferred, 4 ft wide acceptable, 10 ft high (art. 3.2) - Partitions may be installed if at least 6 feet high extending no more than 6 inches past the FL and no more than 18 inches behind the FL (art. 3.8) | Minimum 5 foot width per station, each station numbered (art. 7.1.5.7) | Do not use stations closest to walls -- 4 foot width | Min 4 ft wide (art. 3-2 a1a) | Provide stall separators extending downrange with signals from RSO (p.8) |

Summary of Source Guidance Material Continued

| Item | OSHA/EPA References 7,8,9,11 | NIOSH Reference 2 | Army Reference 5 | Navy Reference 4 | Air Force Reference 1 | UFC Reference 6 | Army National Guard Reference 3 | US Marshals Draft Guide – Reference 10 |
|-------|------------------------------------|---|---|--|--|---|--|---|
| Floor | | Made of dense continuous concrete or steel with smooth surface (p.18) – include drain and trap (p.18) | | Smooth dense floor, no carpets (art. 3.3.2) | Smooth steel trowel- finished concrete and protected with waterproof sealant (art. 7.2.5) | Concrete with surface seal (art. 2- 1.5) | | Hardened and sealed concrete floors min 100mm (p.15) |
| Walls | | | See Table 6- 1 for thickness information (art. 6-2) | | Reinforced concrete or masonry or hardened steel, not sealed or painted (art. 7.2.6) - thickness as noted in Table 4 (art 7.5.5) – Plug all openings downrange with ballistic safety structures (art. 7.2.7) – extends above top of overhead baffles | Seal all wall and roof joints and penetrations (art 2-1.3) – concrete or masonry with surface seal (art. 2- 1.5) | | Sealed walls 200mm minimum fully grouted CMU or concrete (p.15) – do not derate areas walls and floor behind the firing line (p.16) |

Summary of Source Guidance Material Continued

| Item | OSHA/EPA References 7,8,9,11 | NIOSH Reference 2 | Army Reference 5 | Navy Reference 4 | Air Force Reference 1 | UFC Reference 6 | Army National Guard Reference 3 | US Marshals Draft Guide – Reference 10 |
|---------|------------------------------------|----------------------|---------------------|---|---|---|---|--|
| | | | | | and minimum 3.2 feet behind FL (art. 7.5.5)– | | | |
| Baffles | | | | 30 degrees to ceiling made of steel plate with splatter protection if 40-50 feet beyond FL (art. 3.3.3) | No ‘blue-sky’ space (see drawing)– overlap baffles 6 inch from one baffle to next (art. 7.5.)- no gaps between adjacent plates of more than 0.0625 inches (art. 7.5.2) – See table 3 for steel req., Install plywood and sheathing on baffles within 16 feet of FL (art 7.5.4) - baffles at least 8 feet above lower line | Canopy baffle 3/8” AR500 steel from 3 feet behind FL to 12 ft in front of FL, provide 1½” gap with belting or plywood over steel for splatter protection (art. 2-1.8) – Ovhd. baffles to prevent roof impacts of commercial baffling, | See table (p5&6) for plate thicknesses | Steel plate baffles, use splatter protection with airspace and fire rated plywood (ASTM E 84), use 30 degree angle (p.12-13) |

Summary of Source Guidance Material Continued

| Item | OSHA/EPA References 7,8,9,11 | NIOSH Reference 2 | Army Reference 5 | Navy Reference 4 | Air Force Reference 1 | UFC Reference 6 | Army National Guard Reference 3 | US Marshals Draft Guide – Reference 10 |
|---------------|------------------------------------|--|---------------------|--|---|---|--|---|
| | | | | | of fire (art. 7.5.1) – Canopy Baffle at least 3 feet behind line and 14 feet in front of line (art. 7.5.1) | splatter protection for 50 feet from FL (art. 2-1.11) | | |
| Backstop/Trap | | Anchor trap to structure without energy absorbing anchor to reduce noise and vibration (p.16) | | Plate and pit trap not recommended (art. 3.4.1)– Venetian blind trap edges must be kept sharp (art. 3.4.3) – Select based on facility needs (art. 3.5) – Maintain according to manufacturer (art. 3.6) | Backstop a min of 49 feet behind target line (art. 7.5.6.2) - commercial traps OK but should meet specified reqs (art 7.5.6.4) | Recommend d 17 feet from target line for trap and added 10 feet for cleanup area (art. 2- 1.4.1) – Use commercial trap of steel escalator or granular rubber type (art. 2-1.12) | Maintain blind type units with knife edge (art. 3-2 a1b) – commercial type for 0.45 ACP or 9mm parabellum (art. 3-2 a4a) – see table (p5&6) for plate thicknesses (art. 3-2 a4b) | 4 types of traps, escalator, venetian blind, rubber composite and rubber lamella (p.4) |

Summary of Source Guidance Material Continued

| Item | OSHA/EPA References 7,8,9,11 | NIOSH Reference 2 | Army Reference 5 | Navy Reference 4 | Air Force Reference 1 | UPC Reference 6 | Army National Guard Reference 3 | US Marshals Draft Guide – Reference 10 |
|---------------------------|------------------------------------|----------------------|---------------------|--|--|---|--|--|
| Firing Line | | | | | Red line 4 inches wide at edge of firing position (art. 7.1.5.7.3) | Consider in Range Design Review (art. 2.1-16) | | |
| Ready Line | | | | | Yellow line 4 inches wide at least 8 feet behind FL (art. 7.1.5.8) | Recommended 15 feet back from FL for ready and plenum (art. 2-1.14.1) | | |
| Length of range - targets | | | | 50 to 100 ft, 84'4" FL to target referenced as standard but others acceptable (art. 3.1) – Use target retrieval systems (art. 3.7) | | Lanes 136 feet in length, 84 feet FL to target (art. 2-1.4.1) | Use target retrieval system (checklist) | Max target distance is 25 meters (p.7) -Use motorized target retrieval (p.6) |

Summary of Source Guidance Material Continued

| Item | OSHA/EPA References 7,8,9,11 | NIOSH Reference 2 | Army Reference 5 | Navy Reference 4 | Air Force Reference 1 | UFC Reference 6 | Army National Guard Reference 3 | US Marshals Draft Guide – Reference 10 |
|--------------------------|------------------------------------|---|---------------------|---------------------|--|--|--|---|
| Range Control Station | | Paint in sift colors, provide sound attenuation (p.17) | | | Locate behind Ready Line, permit unimpeded view of Firing Line, design must not impede ventilation airflow (art. 7.2.10.1.1); Min 5 x 10 room and align long side parallel to firing line (art. 7.2.10.1.2); Elevate booth 2 ft to provide unimpeded view of firing line and target line and all range entry points (art. 7.2.10.1.3); Provide with min 2.5 x 4 table, at least 1 elec. Outlet, provide red and | Provide modem access to ventilation controls (art. 2-1.3) – recommend 10 foot front to back (art 2- 1.4.1) – provide 4 ft wall to wall window facing FL, provide min 2 ft wide table below window (art. 2-1.6) | | Provide space for 4 shooters and RSO (p.5) - Pressurize with 5% greater supply than exhaust (p.19) – use fluorescent lighting (p. 20) |

Summary of Source Guidance Material Continued

| Item | OSHA/EPA References 7,8,9,11 | NIOSH Reference 2 | Army Reference 5 | Navy Reference 4 | Air Force Reference 1 | UFC Reference 6 | Army National Guard Reference 3 | US Marshals Draft Guide – Reference 10 |
|------------------------------------|--|--------------------------------------|---|---|---|---|--|---|
| | | | | | white lighting for night/limited visibility ops (art. 7.2.10.1.4) | | | |
| Exposure | | | | | | | | |
| Air Concentrations in Range | EPA cites ambient air quality standard of 1.5 ug/m ³ for lead (provides measuremen t method) – OSHA cites the 50 ug/m ³ standard for 8-hour exposure | 200ug/m ³ in '75 (p.5) | Target of 30 ug/m ³ (art. 2-6) - See Table 2-1 for limits of exposure (art. 2-6) | OSHA 50 ug/m ³ PEL art. 2.4.4.1) – 30 ug/m ³ action level, if exceeded medical and exposure monitoring are triggered (art. 2.4.4.2) | OSHA PEL: 50 ug/m ³ for 8-hr TWA; total daily exposure may not exceed 400 ug (art. 7.2.8.6) | Consider in Range Design Review (art. 2.1-16) | Lead levels below 50 ug/m ³ (art 3-2 a6a) – CO levels below 35 ppm (art. 3-2 a6b) | OSHA 50 ug/m ³ PEL and 30 ug/m ³ action level (p.13) |
| Dust Concentrations in Range | | | | 200 ug/ft ² OSHA guideline for non-lead areas (art. 2.4.5) | | Consider in Range Design Review (art. 2.1-16) | | |

Summary of Source Guidance Material Continued

| Item | OSHA/EPA References 7,8,9,11 | NIOSH Reference 2 | Army Reference 5 | Navy Reference 4 | Air Force Reference 1 | UFC Reference 6 | Army National Guard Reference 3 | US Marshals Draft Guide – Reference 10 |
|----------------------|------------------------------------|--|----------------------------------|---|--|--|--|---|
| Ventilation | | | | | | | | |
| Air Flow at FL | | Min of 50 fpm (p.12)– better at 75 fpm (p.12)– minimum downrange velocity of 35 fpm (p.22) | 0.18 meters/sec (art. 2-6) | 75 fpm avg. preferred, 50 fpm minimum with laminar flow, downgradien t flow at 30 fpm min (art. 4.3) – see test requirements (art. 5.2) | 75 fpm ± 5% laminar flow (art. 7.2.8.1) | Avg 75 fpm (0.38mps) ± 10%, nowhere less than 50 fpm, laminar flow, measure at 3 points at each station 1, 3, & 5 ft high (art. 2- 1.3) | Min of 50 fpm (art. 3-2 a2a) – See test procedures (App F) | Maintain velocity at 0.38 m/sec and laminar flow(p.18) |
| Negative Pressure | | Slight negative pressure (p.13) | | 0.04 ± 0.02” H2O (art. 4.1.1) | Maintain a slight negative pressure; All doors into the negative pressure area must have air locks. (art. 7.2.8.3) | 0.04 ± 0.02 “ H2O (art. 2-1.3) | Maintain negative pressure (art. 3-2 a2e) | Maintain negative pressure (p.18) |

Summary of Source Guidance Material Continued

| Item | OSHA/EPA References 7,8,9,11 | NIOSH Reference 2 | Army Reference 5 | Navy Reference 4 | Air Force Reference 1 | UFC Reference 6 | Army National Guard Reference 3 | US Marshals Draft Guide – Reference 10 |
|-------------------------------|---|--|---------------------|--|---|---|---|---|
| Exhaust Flow and Discharge | 1.5 ug/L ambient air lead standard | Locate intake upwind of exhaust (p. 11)– intake filtered (p.11)– exhaust at trap or if 75 fpm 25% 20 ft downrange and rest at trap (p.12) – HEPA filter on exhaust (p.12)– exhaust exceed supply by 10% (p.21) | | 3 – 7 % flow above supply air (art. 4.1.1) – Position exhaust away from range and building intake (art. 4.4.2) – locate exhaust intake at or behind trap (art. 4.3) | 3 – 7 % flow above supply air (art. 7.2.8.3) – Position exhaust away from range and building intake (art. 7.2.8.5) – locate exhaust intake at or behind trap (art. 7.2.8.4) | Provide 2 or 3 stage exhaust filters with final being HEPA (art. 2-1.3) | Exhaust air taken at or behind trap (art. 3-2 a2b) | Exhaust air at 1.5 ug/m3 (p.14) – Exhaust exceeds supply by 5% min. (p.18) - locate exhaust away from intake, filter exhaust with 83% dust removal pre-filter and HEPA, minimize ductwork between range and filters (p.18) |
| Recirculation Air | | | | Not allowed (art. 4.4.1) | Not allowed (art. 7.2.8.3) | Not allowed (art. 2-1.3) | Not allowed (art. 3-2 a2f) | Not allowed (p.18) |

Summary of Source Guidance Material Continued

| Item | OSHA/EPA References 7,8,9,11 | NIOSH Reference 2 | Army Reference 5 | Navy Reference 4 | Air Force Reference 1 | UFC Reference 6 | Army National Guard Reference 3 | US Marshals Draft Guide – Reference 10 |
|--------|------------------------------------|--|---------------------|---|---|---|--|--|
| Fans | | Interlock fans (p.13) – no multi-speed fans (p.13) | | No multi-speed fans (art. 4.1.1) – Interlock exhaust and supply to run simultaneously (art. 4.1) | Supply and exhaust fan systems must have control interlocks to ensure simultaneous operation. (art. 7.2.8.3) | Provide telephone/modem comm to computer that controls vent system. Install in RSO Control Room (art. 2.1-3); Consider in Range Design Review (art. 2.1-16) | Fans interlocked (checklist) | Interlock supply exhaust and lighting (p.18) |
| Plenum | | Min 15 feet behind shooter (p.13) | | See perforated wall design info, min 15 feet behind FL (art. 4.2.1) – Doors in Plenum wall not recommended (art. 4.2.1) | Perforated air distribution plenum or other distribution fixture along rear wall to provide unidirectional airflow across the firing line and continuing downrange; | Use radial plenum (art 2-1.3) - recommend 15 feet back from FL for ready area and plenum (art. 2-1.4.1) | Min. 15 feet from plenum to FL (checklist) | 3 meters from plenum to firing line (p.25) |

Summary of Source Guidance Material Continued

| Item | OSHA/EPA References 7,8,9,11 | NIOSH Reference 2 | Army Reference 5 | Navy Reference 4 | Air Force Reference 1 | UFC Reference 6 | Army National Guard Reference 3 | US Marshals Draft Guide – Reference 10 |
|----------|------------------------------------|---|---------------------|---|--|---|---|--|
| | | | | | Minimum 16.4 feet behind FL (art. 7.2.8.2) | | | |
| Ductwork | | Inspect and monitor duct velocities regularly (p.19) | | | | Must be symmetrical , provide vortex damper to control exhaust flow (art. 2- 1.3) | | Galvanized steel meeting SMACNA (p.18) |
| Lighting | | | | Uniform lighting (art. 3.10) - 85- 100 ft- candles at target 4 feet above floor (art. 3.10.2) – 30 ft- candles at bullet trap | Design downrange lighting (both red and white light) IAW the IESNA Lighting Handbook. 914 - 1076 lux (85 - 100 ft-candles) at target face; 47-in above | General illumination (including spot or floodlights at targets) throughout range, 85- 100 ft candles at target 4 ft | Uniform, non- glaring, shadowless, 75 ft candles at target, 30 ft candles all other areas (art. 3-2 a3a) | Incandescent on range at 500LUX, target illumination on dimmer, controlled by RSO (p.20) |

Summary of Source Guidance Material Continued

| Item | OSHA/EPA References 7,8,9,11 | NIOSH Reference 2 | Army Reference 5 | Navy Reference 4 | Air Force Reference 1 | UFC Reference 6 | Army National Guard Reference 3 | US Marshals Draft Guide – Reference 10 |
|--------------|------------------------------------|--|---------------------|--|---|---|--|---|
| | | | | (art. 3.10.3) | floor. 322 lux (30 ft-candles) for white light general range illumination and 107 lux (10 ft- candles) for red lights. Dimmer controls in RSO control room. (art 7.2.10.3) | above floor; banks of fluorescent lights with suppl. metal halide fixtures; provide dimmer and multi-level switching for various training reqs (art. 2-1.13) | | |
| Noise | | Peak impulse less than 140 db (p.15) - says to use acoustical dampening material and carpet behind FL (p.16) | | Max 84 dbA 8-hr TWA (art. 2.5.3.1) – 140db peak/pulse level (art. 2.5.3.3) – acoustical material allowed behind FL is easily cleaned (art. 2.5.3.4) | Ambient noise levels at the firing line should not exceed 85 dBA to improve communication between shooters and RSO; IFR design must prevent the reflection of these higher noise levels | Consider acoustics in Range Design Review (art. 2.1-16) | | Use acoustical material in shooting area with absorption coefficient of 0.62 at 500Hz, reverb less than 0.4 seconds – above range sound attenuated by 46 to 51 db, 60 db if noise sensitive, same floor sounds |

Summary of Source Guidance Material Continued

| Item | OSHA/EPA References 7,8,9,11 | NIOSH Reference 2 | Army Reference 5 | Navy Reference 4 | Air Force Reference 1 | UFC Reference 6 | Army National Guard Reference 3 | US Marshals Draft Guide – Reference 10 |
|-------------------|------------------------------------|----------------------|---------------------|---------------------|---|--------------------|--|---|
| | | | | | (>85-160+ dBA during shooting) by using sound-absorbing materials; Blown-on acoustic material and carpeting are not permitted; Hearing protection for shooters will provide protection against this noise. (art. 7.2.9); Ambient noise from the ventilation system will not exceed 85 dBA behind the firing line (art. 7.2.8.1) | | | attenuated by 30 db , 50 db if noise sensitive – Coordinate acoustical material with fire protection (NFPA 101) (p.10-11) |
| Operations | | | | | | | | |

Summary of Source Guidance Material Continued

| Item | OSHA/EPA References 7,8,9,11 | NIOSH Reference 2 | Army Reference 5 | Navy Reference 4 | Air Force Reference 1 | UFC Reference 6 | Army National Guard Reference 3 | US Marshals Draft Guide – Reference 10 |
|--------------|------------------------------------|----------------------|---------------------|---------------------|--|--|--|--|
| Range Access | | | | | All doors into the negative pressure area must have air locks. (art. 7.2.8.3); Barriers in the form of key-operated, locked doors or electrically locked doors to prevent entry while firing is in progress. (art. 7.2.11.1); Install fence around exposed fully contained IFRs; Provide a locked access gate for maintenance equip. (art. 7.2.1.3); | At least one two-door air lock entry, provide single door with seal and alarm for access to trap, no openings between FL and trap (art. 2-1.7) | | Provide door at trap for escalator and rubber composite, opens to exterior with non master key lock and sign (p.8) |

Summary of Source Guidance Material Continued

| Item | OSHA/EPA References 7,8,9,11 | NIOSH Reference 2 | Army Reference 5 | Navy Reference 4 | Air Force Reference 1 | UFC Reference 6 | Army National Guard Reference 3 | US Marshals Draft Guide – Reference 10 |
|----------------|------------------------------------|--|---------------------|---|---|---|---|---|
| Signs/Alarms | | | | Use range in use lights (art.3.10.3) - alarm for break of FL or inoperative ventilation (art. 3.11) | Figure 7. Typical Range Signs; Table 2. Locations of Warning Signs (art. 7.2.11.4) | Consider in Range Design Review (art. 2.1-16) | Signs on ammunition authorized, restricting food, beverages , requiring washing after session , required eye and hearing protection (checklist) | Provide visual stop fire alert on alarms and RSO manual (p.7) - signs on hearing and eye protection, safety , procedures, types of ammunition allowed prohibit eating, smoking and drinking, etc.(p.8) - alarm across HEPA filter (p.18) |
| Communications | | | | | Permanent hard wired public address system (art. 7.2.10.2) | 1 or 2 way paging system (art. 2-1.14) | | Provide CCTV intercoms and alarms (p.5) |
| Procedures | | Wear hearing protection (p.16) – no eating drinking or smoking (p.25) – | | Regular range assessments (art. 5.0) – Train users, no shooter past the FL, provide | Range Occupational Health Standards monitored regularly. (art. 7.2.4) | Provide operating procedures (art. 2- 1.14.1) – Provide regular maintenanc | Provide operating instructions, maintain user time records (art. 2-8 a) - All shooters wear | Provide sticky mats (p.8) |

Summary of Source Guidance Material Continued

| Item | OSHA/EPA References 7,8,9,11 | NIOSH Reference 2 | Army Reference 5 | Navy Reference 4 | Air Force Reference 1 | UFC Reference 6 | Army National Guard Reference 3 | US Marshals Draft Guide – Reference 10 |
|---|------------------------------------|--|---------------------|---|---|--|---|--|
| | | Establish regular maintenance schedule (p.25) | | sticky mats at exits (art. 5.5.1) – No food, alcohol, tobacco or gum on range (art. 5.5.2) – only weapons and ammo to range, personal effects leave outside (art. 5.5.6) | | e (art. 2-2) | approved eyewear (ANSI Z87.1) (art 3-5 a) – All shooters wear hearing protection (art. 3-5 b)- Inspections every 2 years using form and lead sampling (art. 4-3 & 5-1 c) | |
| Peripheral areas/Support facilities | | Provide sanitary facilities and sound attenuation in adjacent areas (p.17) – Storage and cleaning areas recommend ed (p.17) | | Provide sanitary and washing facilities (art. 5.5.4) | Provide sanitary and washing area (art 7.6.1.7); Weapons cleaning/degreas ing room should have exhaust and ventilation air, vapor-proof elec. Fixtures, compressed air | Consider sanitary, drinking, eyewash station and storage areas (art. 2- 1.15.2) | | Provide 3 trash bins (brass casings, general, oily waste from cleaning), coat rack, storage vault, weapons cleaning area, storage space for targets |

Summary of Source Guidance Material Continued

| Item | OSHA/EPA References 7,8,9,11 | NIOSH Reference 2 | Army Reference 5 | Navy Reference 4 | Air Force Reference 1 | UFC Reference 6 | Army National Guard Reference 3 | US Marshals Draft Guide -- Reference 10 |
|-----------------|------------------------------------|--|---------------------|---|--|--|---|---|
| | | | | | service, solvent resistant walls and ceiling finishes; emergency eyewash station (art. 7.6.1.5); Weapons/ammo storage – secure vault, with walls, floors, and roof of 200 mm concrete reinforced with 2 layers of No. 4 rebar on 225 mm centers, fitted with a class V door, maintain RH below 65%. (art. 7.6.1.6) | | | |
| Cleaning | | Wear respirator when cleaning (p.19) – ventilation on during | | Routine cleaning once or twice a week (horiz. surfaces) with HEPA | Clean IFR floors using approved “dry” methods, such as HEPA-filtered vacuuming or damp mopping. | Provide HEPA vacuum for floors and 2 stage vacuum for granular | Provide cleaning procedures and document, see detailed instructions | |

Summary of Source Guidance Material Continued

| Item | OSHA/EPA References 7,8,9,11 | NIOSH Reference 2 | Army Reference 5 | Navy Reference 4 | Air Force Reference 1 | UFC Reference 6 | Army National Guard Reference 3 | US Marshals Draft Guide – Reference 10 |
|------|------------------------------------|---|---------------------|---|---|------------------------------------|---|--|
| | | cleaning (p.24) – use only HEPA vacuum or wet methods (p.24) | | vacuum or wet methods, use dedicated equipment, provide protective clothing and training for maintenance and cleaning personnel, dry sweep or blow prohibited, ventilation on (art. 5.4) – Comprehens ive cleaning annually (App. A) | Water wash- down or dry sweeping is not permitted. (art. 7.2.5) | rubber trap (art. 2- 1.15.1) | (App B & C) (art. 2-8 b) - Use respirator during cleaning (art. 3-5 c1) – If levels exceed 0.5 mg/m3 use supplied air (art. 3-5 c2) – ventilation on (art. 3-5 c3) – wear protective clothing (App B-2 d) – wet cleaning (two containers) or HEPA vacuum acceptable App B-2) | |

Appendix B

Ballistic Safety References

Indoor firing ranges should not be designed to accommodate weaponry and ammunition that exceed a muzzle velocity of 1500 feet per second.

Acceptable ammunition and corresponding muzzle velocities that can be utilized on indoor firing ranges is presented in the table below. This table also presents the minimum armor plating thickness for ballistic safety components for various types of ammunition.

**Examples of Acceptable Ammunition, Muzzle Velocities and
Minimum Steel Plate Thickness for
Metal Backstops, Deflector Plates, and Bullet Traps**

| Ammo | Muzzle Velocity (feet/sec) | Armor Plate/ 300 BHN | 440 BHN | 500 BHN |
|-----------------------------|-------------------------------|-------------------------|---------|---------|
| .22 LR rim fire / 29 Grain | 1100 | 6 mm | 6 mm | 6 mm |
| .38 Special / 125 Grain JHP | 1375 | 10 mm | 6 mm | 6 mm |
| .357 Sig / 125 Grain JHP | 1357 | 10 mm | 6 mm | 6 mm |
| .45 cal. / 230 Grain JHP | 890 | 10 mm | 6 mm | 6 mm |
| 9mm / 124 Grain JHP | 1220 | 10 mm | 6 mm | 6 mm |
| 9mm / 147 Grain JHP | 985 | 10 mm | 6 mm | 6 mm |
| .40 cal. / 155 Grain JHP | 1200 | NE | NE | NE |
| .40 cal. / 165 Grain JHP | 1150 | NE | NE | NE |
| .40 cal. / 180 Grain JHP | 1025 | NE | NE | NE |

Note: 0.25-inch and 0.375-inch plate may be substituted for 6-mm and 10-mm plate, respectively.
Grain – the weight of gunpowder in the ammunition. A grain is equivalent to 0.0648 grams. There are 5760 grains to a pound.

JHP – Jacketed Hollow Point

NE – Not Established in the ETL 08-11

BHN - the Brinnell Hardness Number (BHN) measures steel hardness. The higher the BHN, the harder the steel.

Sources:

- 1) ETL 08-11 (Engineering Technical Letter) – Small Arms Range Design and Construction; 20 Oct 2008
- 2) U.S. Marshals Service, Southern District of Texas, Victoria Division
- 3) Ballistics Chart for Handgun Cartridges (link: www.Handgunsmag.com)

Appendix C
Range Acoustics Guidance

Range Acoustics Guidance

Reference: DRAFT U.S. Marshals Pistol Range Design Guide - Program Requirements: Range Acoustics

Adjacencies must be considered when locating a range within new and existing buildings. Pistol shot noise has a wide band frequency spectrum. Therefore, regardless of the wall treatment, all occupants within the range area must use personal hearing protection devices. No amount of acoustical structural treatment will protect shooters adequately.

Sound levels inside the range shall be minimized by application of acoustical materials with an absorption coefficient of greater than 0.62 at 500 Hz.

Reverberation time in the range shall be minimized, and shall be less than a calculated value of 0.4 seconds.

Sound levels above the range shall be minimized: a 46 to 51 dB reduction is adequate for non-noise sensitive office space occupancies above the range. Noise sensitive spaces should not be located above the range, but if essential, the ceiling noise reduction must be increased to 60 dB. In terms of the commonly used STC (Sound Transmission Class) rating, the noise reduction values require a STC 55 minimum for non-sensitive adjacencies, and 65 for the noise sensitive case.

Sound levels outside the range on the same floor level shall be minimized. Non-sensitive utility space adjacencies are recommended for areas near the range on the same floor. 30 dB noise reduction from range to these areas is adequate. If noise sensitive office space is essential near range on the same floor, a 50 dB minimum noise reduction is recommended from range to office interiors. This translates to STC 35 for non-sensitive adjacencies and 55 for the noise sensitive case.

All structural, mechanical, plumbing, and electrical penetrations and electrical penetrations throughout the acoustic envelope shall be sealed and isolated to prevent sound transmission. All ductwork penetrating the envelope shall include silencers. Silencers shall be the packless type which will not pick up and hold air contaminants are cleanable.

Ductwork access panel must be provided at all silencers. Silencers shall accommodate air flow requirements.

The noise of bullet's hitting the steel plates of the bullet traps is not readily distinguishable from the gunshot noise, and no special treatment on the traps is required.

The selection of the interior finish product for sound absorption must be coordinated with a GSA Fire Protection Engineer.

Acoustical treatment within the range can be accomplished through the use of a convoluted melamine foam material which is supplied in modular panels. Panels shall be coated to minimize absorption of airborne particulate. Coated material must be easy to clean with mild soap and water and resistant to lead and nitrate penetration. Panels must be installed so they may be easily removed, bagged for disposal, and replaced.

Acoustic material shall be placed on walls, ceilings near the firing line, and ceiling baffles downrange of the firing line. It is not necessary to extend wall acoustical treatment completely downrange since the primary goal of the acoustic treatment is to deaden muzzle blast noise at the firing line. A maximum downrange application of wall acoustical treatment is 3600mm. Acoustical treatment of the walls should start above the floor to provide space for and avoid damage from floor maintenance. Downrange wall treatment would be susceptible to bullet damage and has very little contribution to the acoustics deadening characteristics within the range. Therefore, extensive downrange wall treatment is not required.

The separation between the Firing Line and Range Safety Officer Control Room shall have an STC rating of 55. This wall includes a vision panel which shall be constructed of two panes of glass separated by an airspace for purposes of achieving the highest possible STC rating available for this type of construction. The larger the airspace, the more acoustical separation will be realized. The RSO Control Room side of the vision panel should be sloping to minimize reflections. Glass panels shall be resiliently mounted to reduce noise transmission.